Soil and Water Quality

Name: Soil and Water Quality
Grade: 6th – 8th grade
Topic: Learn how soil interacts with and affects water quality
Time: 45min-1hr

Introduction:

Soil (or dirt) is everywhere, and it is very important to human life. It soaks up water and stores it in underground aquifers for us to drink. It provides an environment for plants to grow. Those plants provide us with food, lumber, paper, clothes, and many other products. They also sequester carbon from the atmosphere, helping to reduce CO2 levels. So, without soil, life as we know it wouldn't be possible.

Now without plants to hold the soil in place, it will be exposed to the elements like rain and wind. Rain can erode the soil and carry it into waterways where it can seriously affect water quality. Soil can clog waterbodies, destroy fish spawning beds, and make it costlier to clean our drinking water. Additionally, soil can transport other harmful chemicals or nutrients. These nutrients, such as nitrogen and phosphorus, can spawn algal blooms that use all the oxygen and kill the fish.

Soil is typically a combination of silt, sand, and clay. The amount of each material in a sample determines the type of soil. Figure 1 shows the Soil Texture Triangle. This tool is used in determining soil types.

Many human activities, such as agriculture and construction, contribute to the erosion of soil by stripping the land of its vegetation that protects it from erosion. These activities are regulated by the

federal, state, and local governments to ensure everything is being done to keep sediment from reaching the water bodies.

This lab activity will demonstrate how soil particle size impacts water quality and some current methods to improve water quality. Three soil samples (clay, sand, riverbank silt) have been provided to demonstrate suspension time in water. A Secchi disk kit has been provided to demonstrate how to measure water turbidity. Lastly, we will demonstrate the effectiveness of time and sediment filter fabric in removing soil from water.

Materials:

Kit will include:

- 50mL Vials (3)
- Plastic 500mL measuring cup
- Plastic Jar w/Soil
- Graduate Cylinder (marked clear tube)
- Nylon Rope
- Zip Ties (2)
- Plastic Disc
- Metal Hex Nut
- Filter Fabric (9”x9” square)
- Paper Cone (2)

Videos and additional Information can be found on the DFW Earth Day website

Additional Materials Needed:

- Water
- Ruler or Tape Measure
- Clock or Stopwatch
- Scissors
- Black Permanent Marker
- Paper Towels for clean up
- Container for Excess Water

Key Terms:

SoiL - mineral or organic material on the surface of the earth that serves as a natural medium for the growth of plants.

Silt - Granular material of a sized between sand and clay.

Sand - Loose granular substance with particles larger than silt.

Clay - Fine-grained natural soil material containing clay minerals and granules smaller than silt

Erosion - process in which earthen materials are worn away and transported by wind or water.

Stormwater - Water that drains off a land area from rainfall or snow and ice melt.

Waterbody - any significant accumulation of water on the surface of the earth such as lakes, and rivers.

Turbidity - quality of being cloudy, opaque, or thick with suspended matter

Nephelometric Turbidity Units (NTUs) - unit used to measure turbidity of a fluid or the presence of suspended particles in water.

Sedimentation - process of allowing particles in suspension in water to settle out of the suspension under the effect of gravity

Procedure:

Observe How Different Soil Types Are Suspended in Water

1. Grab the three 50 mL Vials labeled Sand, Silty Loam and Sediment.
2. Fill each jar with water.
3. Take turns shaking the jars until most of the soil has dissolved.
   - Not all soil will dissolve, but water should be murky and difficult to see through.
4. Place jars in an area where they will not be disturbed and record the time.
5. Record your observations on the worksheet of each soil type at 15 and 30 minutes after.
   - Step 5 could take a long time. Can move on to next experiment while waiting.
   - Figure 2 & 3 on the right shows what the jar should look like after shaking and once it has settled overtime.
6. Once the observations have been recorded, complete the questions below.

Measure Water Turbidity with a Secchi Disc

Make Secchi Disc (refer to video for visual instructions)

1. Tie metal nut to bottom of nylon rope.
2. Strap first zip tie just above the metal nut as closely as possible and cut off the excess.
3. Using permanent marker, divide disc into 4 equal quadrants and color two quadrants that are on opposite sides of each other.
4. Slide disc down nylon rope on top of zip tie that was just strapped on.
5. Strap second zip tie just above disc and cut off excess.
   - Disc should have minimal to no movement on nylon rope.

Secchi Disc Measurement of Turbidity

1. Add water to marked line on one mason jar with soil and shake until soil is dissolved.
2. Immediately pour water/soil mixture into upright clear tube. Fill to marked line.
   - There should be some water remaining in the jar. This will be used for part III.
3. Carefully place secchi disc into top of the clear tube.
4. Slowly lower secchi disc until the black and white disc is no longer visible from the top of the tube looking down.
5. Measure the length of the rope from the secchi disc to the top of the water.
6. Use the table in Table 1 to convert measurement to NTU units and record your results in the table below.
7. Set graduated cylinder in area it will not be disturbed and set timer for 15 minutes. After 15 minutes, repeat steps 3-6

Filter Fabric Test

1. Using the remaining water and soil in the 1L jar, shake until soil is dissolved. Record your observations in the table.
2. Remove the lid of the mason jar and place the filter fabric over the top.

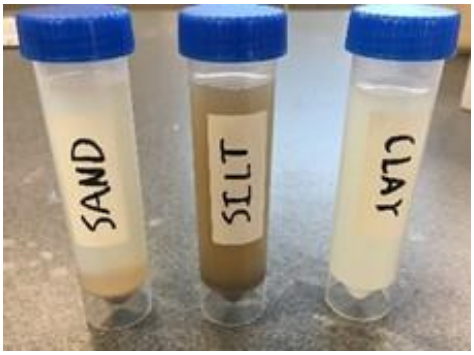

Figure 1: After Shaking

Figure 2: After Settling

3. Use rubber band to firmly attach filter fabric to the jar.
4. Turn jar upside down and allow it to drain into the 500 mL beaker. Wait for all water to drain out of mason jar. Record your observations in the table.

Conclusion/Key Take away:

Soil Types Suspended in Water

Different types of soils have different settling rates due to the particle sizes of each. You can see it takes longer for the clay to settle out versus the sand, but they all take a while to naturally settle out. With rivers and creeks constantly flowing and moving, soil tends to stay suspended. Because of this, soil can use water to travel a very far distance. Soil in Texas can use waterbodies to travel all the way to the Gulf of Mexico. Therefore, it essential for humans to use other methods to help with removing soil from stormwater.

Secchi Disc

Native soil typically isn't just sand, silt or clay, but rather a combination of the 3. Therefore, sedimentation will work better in some areas than others depending on the composition of the soil. The secchi disk measures the turbidity of water and gives us an idea of the amount of soil in it. You can see it doesn't take much soil to muddy up the water and it takes a long time for it to settle out naturally. The World Health Organization (WHO) states drinking water should never exceed 5 NTUs and ideally be below 1 NTU. It can take a lot of money to clean out a little dirt from drinking water.

Filter Fabric Test

Filter fabric is commonly used on construction sites to filter soil from stormwater runoff. Filter fabric is not perfect, but it does help remove soil. You can see from the test that the bigger sized particles (sand & silt) are easily removed, while the smaller particles (clay) aren't filtered as well. Therefore, other control measures are needed in combination with the filter fabric to keep all soil on site.

Adaptations:

K-5

- Secchi disc can be made ahead of time and the teacher can conduct the turbidity measurement in front of class.

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- Prior to adding the water. Analyze the soil and estimate the percentages of each soil type. Use the soil texture triangle in figure 1 to identify the type of soil.
- Take additional Secchi disc measurements every 15 minutes. Graph turbidity vs time and add a trendline. From graph try and predict when enough soil will settle out to achieve drinking water clarity, 5 NTU or less.
- Measure amount of soil removed by filter fabric test. Try to determine if more clay, silt, or sand was removed.

Table 1

Length of Rope (in)	NTU's
<2.4	> 240
2.4-2.8	240
2.8-3.1	185
3.1-3.5	150
3.5-3.9	120
3.9-4.7	100
4.7-5.5	84
5.5-6.3	60
6.3-7.5	48
7.5-8.3	40
8.3-9.4	35
9.4-10.2	30
10.2-11.4	27
11.4-12.2	24
12.2-13.4	21
13.4-14.2	19
14.2-15.4	17
15.4-16.1	15
16.1-17.3	14
17.3-18.1	13
18.1-19.3	12
19.3-20.1	11
20.1-21.3	10
21.3-22.4	9
22.4-23.6	8
23.6-27.6	7
27.6-33.5	6
> 33.5	< 5

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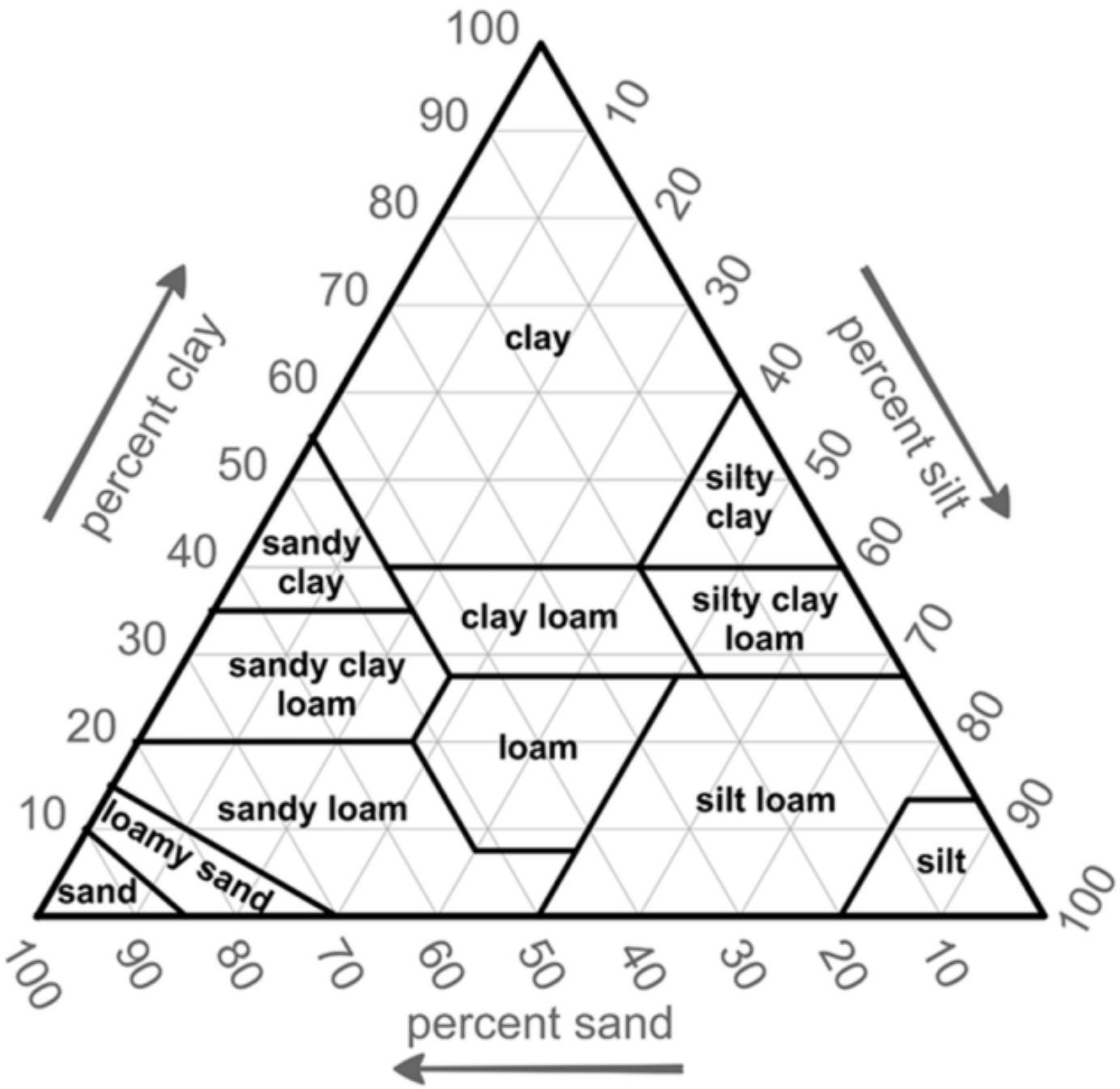
Figure 1



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Soil and Water Quality Worksheet

Observe How Different Soil Types Are Suspended in Water

1. Complete the table below

Time	Sand	Silt	Sediment
Start Time:			
After 15 minutes:			
After 30 minutes:			

2. Compare the three soil types ability to stay suspended in water. Which soil type took the longest to settle to the bottom? Shortest?

3. Did all 3 soil types settle out to the bottom within the 30 minutes?

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II. Use a Secchi Disc to Measure Turbidity

1. Complete the table below**.**

Time	Rope Length	NTU

2. Did the turbidity improve over time?

3. How long do you think it will take for all soil to settle out to the bottom of the graduated cylinder?

III.Filter Fabric Test

1. Sketch the water quality before passing through the filter fabric and after.

Water Prior to Filtering	Water After Filtering

2. Describe what the filter fabric does?